Integrating ecological dynamics in primary school physical education: a systematic review of nonlinear pedagogy

Integración de dinámicas ecológicas en la educación física de la escuela primaria: una revisión sistemática de la pedagogía no lineal

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Abstract

Purpose: This literature review aims to investigate the application of nonlinear pedagogy in a sports context, including its impact on game skill acquisition and skill transfer between games. The research background details Nonlinear pedagogy, which is grounded in ecological.
Method: This review included peer-reviewed studies published from 2018 to January 2025, which used both qualitative and quantitative methodologies. The included studies examined nonlinear pedagogy, with a focus on ecological approach and their relationship to physical education.
Result: present the main findings regarding potential benefits and practical challenges of adopting nonlinear pedagogical frameworks in sports and physical education. The practical ramifications of these discoveries are substantial. for educators, coaches, and sports practitioners who aim to implement nonlinear pedagogy (NP) and ecological dynamics frameworks in their practice.
Conclusion: This Research shows that nonlinear pedagogy and ecological dynamics offer powerful frameworks for understanding skill acquisition and learning in sports. This research establishes a basis for creating more successful teaching and coaching practices that emphasize adaptation, exploration and learner-centered approaches. However, practitioners must remain flexible in applying these methods across different contexts and sports. This study offers scientific insights and practical suggestions for applying nonlinear pedagogy in diverse sports and educational settings.

Keywords

Student centered learning, nonlinear pedagogy, physical education.

Resumen

Objetivo: Esta revisión bibliográfica tiene como objetivo investigar la aplicación de la pedagogía no lineal en un contexto deportivo, incluido su impacto en la adquisición de habilidades de juego y la transferencia de habilidades entre juegos. Los antecedentes de la investigación detallan la pedagogía no lineal, que se basa en la ecología.
Método: Esta revisión incluyó estudios revisados por pares publicados entre 2018 y enero de 2025, que utilizaron metodologías tanto cualitativas como cuantitativas. Los estudios incluidos examinaron la pedagogía no lineal, con un enfoque en el enfoque ecológico y su relación con la educación física.
Resultado: presentar los principales hallazgos sobre los posibles beneficios y desafíos prácticos de la adopción de marcos pedagógicos no lineales en el deporte y la educación física. Las ramificaciones prácticas de estos descubrimientos son sustanciales para educadores, entrenadores y profesionales del deporte que buscan implementar marcos pedagógicos no lineales (PN) y de dinámica ecológica en su práctica.
Conclusión: Esta investigación muestra que la pedagogía no lineal y la dinámica ecológica ofrecen marcos poderosos para comprender la adquisición y el aprendizaje de habilidades en los deportes. Esta investigación establece una base para crear prácticas de enseñanza y entrenamiento más exitosas que enfaticen la adaptación, la exploración y los enfoques centrados en el alumno. Sin embargo, los profesionales deben mantener la flexibilidad a la hora de aplicar estos métodos en diferentes contextos y deportes. Este estudio ofrece perspectivas científicas y sugerencias prácticas para aplicar la pedagogía no lineal en diversos entornos deportivos y educativos.

Palabras clave

Aprendizaje centrado en el estudiante, pedagogía no lineal, educación física.

Introduction

In recent years, there has been a significant shift in how learning and skill acquisition are understood in sports and physical education. Traditional, linear approaches to teaching, which emphasize repetition and prescriptive drills, have been increasingly challenged by more dynamic and flexible frameworks. Some of these approaches are Nonlinear Pedagogy (NP), which is grounded in the theory of Ecological Dynamics (M. C. Y. Lee et al., 2017), Ecological dynamics approach in physical education (Adé et al., 2022; Rudd et al., 2021), Conceptualizing physical literacy within an ecological dynamic (O'Sullivan et al., 2020; Rudd et al., 2020) and Physical Literacy for Educators of Children with Disabilities, from an Ecological Systems Framework (Pushkarenko et al., 2023). This pedagogical framework emphasizes the non-linear nature of learning, where skills emerge through the interaction of various constraints such as task demands, environmental factors, and individual characteristics.

The Constraints-Led Approach (CLA), a core element of NP, offers a practical method for coaches and educators to design learning environments that encourage exploration and adaptability (Pinder & Renshaw, 2019; Renshaw et al., 2016). By manipulating constraints, practitioners can guide learners to self-organize their behaviors, fostering the development of skills that are adaptable to changing game situations. This approach contrasts with traditional methods that focus on consistency and repetition to perfect movement patterns.

The importance of understanding these frameworks lies in their potential to inform coaching practices and educational strategies within sports (Jacobs & Wright, 2018). As highlighted by Sullivan et al. (2021), adopting a constraints-led approach (CLA) allows practitioners to create learning settings that promote adaptability and exploratory tendencies in athletes. The transition from conventional, teacher-focused methods to more interactive, learner-centered strategies is essential for meeting the varied requirements of athletes in competitive environments.

Moreover, recent studies have begun to illustrate the practical implications of nonlinear pedagogy in various sports contexts. For instance, Chow et al. (2023) demonstrated how manipulating constraints can enhance the acquisition of game skills in team sports, while Rudd et al. (2020) explored the broader implications of ecological dynamics for physical education as a whole. These findings underscore the necessity for a comprehensive understanding of how these pedagogical models can be effectively integrated into coaching practices.

Despite its theoretical strengths, implementing NP in real-world settings presents challenges. The complexity of managing dynamic learner-environment interactions requires a fundamental shift in how educators and coaches design their sessions. Instead of being solution providers, they must become learning environment designers, creating conditions that promote self-regulation and problem-solving (Rudd et al., 2019; Wibowo & Dyson, 2021).

This body of research aims to provide both scientific insights and practical guidance on how NP can be integrated into sports coaching and physical education. Through empirical studies and case examples across various sports contexts such as football, handball, and physical education this research explores the effectiveness of NP in enhancing skill acquisition, its potential for skill transfer across different games, and the challenges practitioners face when adopting this approach.

By focusing on adaptability, exploration, and learner-centered approaches, this study provides a foundation for developing more effective teaching methodologies that align with the complex realities of sports performance and education (J. Y. Chow et al., 2023; Rein et al., 2010).

This review will systematically analyze the literature on nonlinear pedagogy and ecological dynamics, focusing on their theoretical foundations, practical applications, and impact on athlete performance. By collating insights from multiple studies, this research aims to provide a robust framework for educators and coaches seeking to enhance their pedagogical approaches and ultimately improve athlete outcomes in dynamic sporting environments. Through this synthesis, we hope to contribute to the ongoing dialogue surrounding effective teaching and learning practices in sports education.

The remaining sections of this paper are organized as follows: Section 2 examines all research methodology, Section 3 result, Section 4 discussion, and Section 5 conclusions with some recommendations for future research.

Method

Systematic Design (Systematic Review)

This study technique will employ a systematic approach in accordance with the PRISMA Guidelines for Screening and Reporting Information for Systematic Reviews and Meta-Analyses. This study will adhere to the PRISMA standards to guarantee a transparent and well documented literature selection procedure. Rigorous inclusion criteria will be implemented in accordance with PRISMA guidelines to guarantee the inclusion of only high-quality studies that align with the study aims.

The literature review will encompass esteemed databases and credible sources pertinent to sports and psychology. The search methodology will be elaborated upon, encompassing search terms, temporal limitations, and the actions undertaken to pinpoint pertinent studies. The selection of studies will be conducted by two or more researchers, and the complete procedure will be detailed in accordance with PRISMA principles. This study employs PRISMA to enhance transparency and precision at every phase of literature selection, hence augmenting the validity and dependability of the results.

Inclusion and exclusion criteria

Table 1. Inclusion and exclusion

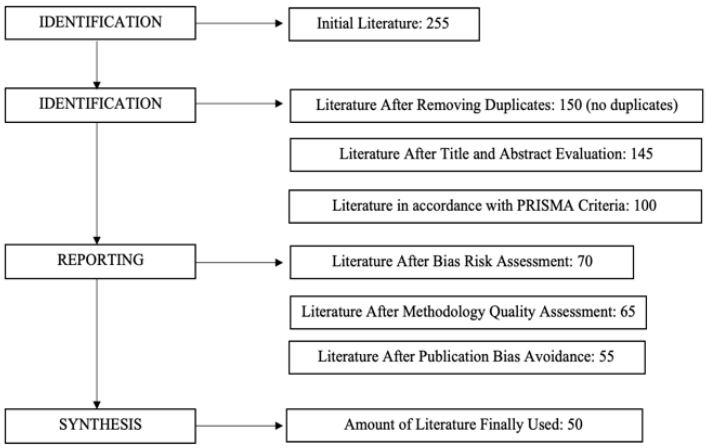
Criteria	Description
Inclusion Criteria	
Research Context	- Studies focused on nonlinear pedagogy and ecological dynamics in sports/physical education - Research examining constraints-led approaches in learning environments - Studies investigating pedagogical applications in sports practice
Research Methods	- Empirical studies (quantitative/qualitative) - Systematic reviews and meta-analyses - Case studies of practical implementation
Study Population	- Physical education teachers and sports coaches - Athletes and students in learning environments - Sports practitioners implementing nonlinear pedagogy
Publication Characteristics	- Peer-reviewed journal articles - Publications between 2019-2024 - Full-text articles in English
Research Variables	- Studies examining nonlinear pedagogical principles - Research investigating ecological dynamics framework - Studies analyzing constraints manipulation in practice
Exclusion Criteria	
Research Context	- Studies not related to nonlinear pedagogy or ecological dynamics - Research without clear pedagogical implications - Studies focusing solely on traditional linear pedagogy
Research Methods	- Non-empirical studies - Studies without clear methodology - Opinion pieces without substantial evidence
Study Population	- Populations not involved in sports or physical education - Studies without clear participant characteristics
Publication Characteristics	- Non-peer reviewed articles - Conference proceedings and book chapters - Publications before 2019 - Articles in languages other than English
Research Variables	- Studies without clear focus on nonlinear pedagogy principles - Research without connection to ecological dynamics or constraints-led approaches

Data analysis

Data analysis techniques will be customized according to the data type present in the specified scientific publications. This systematic methodology, encompassing PRISMA, facilitates the utilization of meta-analysis methodologies as necessary. The procedures for data analysis will be elucidated comprehensively, detailing the methodology for integrating data from several research in accordance with PRISMA recommendations.

This study will incorporate PRISMA guidelines in the research methods to guarantee high accuracy, transparency, and validity in all facets of data selection and analysis, yielding reliable and pertinent findings regarding psychological resilience and performance in elite badminton athletes.

Figure 1. Data Selection Using the PRISMA Method



Literature Review

Definition of Ecological Dynamic

Ecological Dynamics is a multi-disciplinary scientific framework that studies the behavior of neurobiological systems, particularly focusing on processes of action, perception, and cognition (Araújo et al., 2019). This framework views athletes and their environment as an interconnected whole, with a reciprocal relationship between them (Woods et al., 2020).

A crucial element that requires additional examination is to the inextricable link between the emergence of human movement patterns and the surrounding environment. The introduction highlights that comprehending the mutuality and reciprocity between learners and their environment is essential for academics and practitioners to interpret the dynamic development of movement skills. It contests the notion of a universal movement pattern anticipated among all individual learners within performance and educational situations (J. Y. Chow, Komar, & Seifert, 2021). In a throw and catch activity, it is unrealistic to expect that all children will execute the overhand throw with identical movement patterns, although their motions will likely approximate an overhand throw (Buszard et al., 2016). Variations in physiological structure, strength, and flexibility among individual learners will influence the execution of the throw (Yudanto et al., 2024). Inherent differences will occur between throwing trials for the same individual when the task objective varies (e.g., throwing for accuracy versus throwing for distance) or even when the task objective remains constant, as it is not feasible to engage the same muscles for joint movement in an identical manner. This paper will subsequently present empirical evidence to support the previously discussed concepts and instances.

The theoretical foundations integrate principles from ecological psychology and dynamical/nonlinear systems theory, utilizing a complex systems approach to neurobiology and conceptualizing athletes and sports teams as complex adaptive systems (O'Sullivan et al., 2020). The fundamental principles of ecological dynamics encompass the coordination of movement resulting from interactions among environmental factors, task, and performer constraints. Learning transpires through ongoing problem-solving rather than mere rote repetition, and information is perpetually available, maintaining a circular relationship with movement (Thamrin et al., 2024).

Affordances are contingent upon the performance context when the aim is specific transfer, making crucial information pertinent to highly representative performance contexts (J. Y. Chow, Komar, & Seifert, 2021; Woods et al., 2020). For example, training for a specific gameplay within a performance environment may serve as an illustration of this transfer. In contrast, the affordances are diverse and not specific to a particular setting at the opposite generalized end of the continuum, where the transfer of learning is more expansive. The opportunity enables young learners to cultivate a diverse array of movements that are pertinent to similar situations. Significantly, it pertains to "learning to learn" (Hacques et al., 2024). Individuals acquire decision-making skills, engage in exploration, and develop adaptability, all of which can occur over an extended time frame (Hacques et al., 2024). This scenario

may be best illustrated by numerous fundamental movement abilities, including running, catching, and throwing, that are trained outside of a game environment. The invitation to act would be less specific to the specific performance environment and could be applied to a broader spectrum of circumstances.

The development of juvenile athletes is facilitated by the modification of the full-adult form of these activities. It is undeniable that the aesthetic and experiential aspects of junior games are substantially different from those played by adults when they are conducted on adult pitches and courts with adult equipment. Thus, the talents and strategies employed to achieve success are affected by the players' size and power, in addition to their skill level (J. Y. Chow, Komar, & Seifert, 2021). By adjusting pertinent task restrictions like as pitch dimensions, net elevation, and player count, the adapted versions of these games can be rendered more accessible to juvenile athletes. The adjustment of the playing area, target dimensions (e.g., basketball hoop height), and equipment (e.g., smaller rackets) might Improve the efficiency of the acquisition of affordances that are relevant to the unique dynamics of the participants. The design of routines to encourage the development of functional movement behaviors would also be influenced by the participants' involvement in these modified games.

Ecological dynamics have practical uses, including performance analysis. Highlights the performer-environment interaction as the fundamental unit of study (Seifert et al., 2022). Examines how athletes modify and adapt their activities in reaction to varying conditions, and emphasizes the development of coordination patterns through dynamic functional linkages (Hallé Petiot et al., 2021). Advocates for the creation of practice spaces that facilitate experimentation. Advocates for a "repetition without repetition" methodology in skill development and perceives coaches as architects of learning environments rather than mere educators, which also applies to coaching implications (Schöllhorn et al., 2022).

A recent study by Barth and Güllich (2021) The research conducted on elite track and field athletes suggests that the efficacy and performance enhancement of adult practice were significantly influenced by coach-led multi-sport practice during infancy and adolescence. Conversely, it was shown that peer-led participation in any sport did not significantly impact adult practice efficiency. Barth and Güllich (2021) It was hypothesized that the long-term sustainability of athletes' development in athletics can be improved through coach-directed multi-sport training from childhood and adolescence. Güllich et al. (2023) noted that prior practice experiences in different sports had a delayed impact on enhancing skill acquisition in soccer-specific training. Consequently, the advantages of engaging in multiple sports may not be immediately apparent. An essential aspect is the distinction between coach-led and peer-led (or child-led) practices as outlined by Barth and Güllich (2021). The specific micro-structure of these practices (i.e., the design of each session) may require additional examination to clarify the implications of such a comparison. Are these techniques systematic or chaotic? What are the possible differences between coach-led activities and child-led activities, as previously examined in this section? What is the specific role of the coach or instructor in these activities? The previously indicated inquiries will likely require more extensive empirical research in the near future.

Essential characteristics of the information-movement interaction are Information delineates affordances (options for action) within performance contexts. Affordances are distinctive to athletes and can swiftly arise and diminish, whereas movement solutions arise from the interplay of many limitations (Lindsay, 2022).

Consequently, it is evident that the creation of practices is a complex endeavor, necessitating the consideration of a pivotal question: How can practitioners formulate effective practices to enhance the development of Primary School Physical Education? This text examines Nonlinear Pedagogy to emphasize its significance in comprehending how alterations in learning environments might enhance skill acquisition in Primary School Physical Education.

Definition of Nonlinear Pedagogy

Nonlinear Pedagogy encapsulates essential design concepts informed by Ecological Dynamics, aiding practitioners in crafting activities that prioritize the promotion of exploratory behaviors to cultivate personalized movement patterns. A multitude of publications has been authored regarding these design concepts (e.g.,Araújo, Davids, and Hristovski 2006; Chow, McKenzie, and Louie 2009; Rudd et al. 2021). The core design principles include assuring representativeness in practice, prioritizing task simplicity,

acknowledging the impact of informational constraints, comprehending the functional importance of practice variability, and adjusting restrictions.

Representativeness refers to how practitioners might cultivate practices that replicate the execution of movement skills in genuine gaming environments, where relevant perceptual information is accessible to provide the essential affordances for effective outcomes. Practicing basketball shooting without a defender may facilitate general learning transfer; however, it lacks essential perceptual information necessary for effective movement adaptations when students face opponents while attempting a shot at the basket. The predominant transfer emphasis is frequently noted in pedagogical approaches that promote repetition and a defined movement pattern. There is a propensity to integrate a substantial number of practice trials to cultivate a reliable performance output, underpinned by a requisite movement form (i.e., often involving several drills and repetitions without a simulated game context). These methodologies have been referred to in certain empirical studies as Linear Pedagogy (e.g., Crotti et al. 2021; Lee et al. 2014). Empirical evidence regarding the effectiveness of Linear Pedagogy suggests a deficiency in retention and chances for exploratory activities, as demonstrated in Lee et al. (2014) in the context of modified tennis learning. It was observed that learners struggled to recall the anticipated (and instructed) movement technique for the forehand ground stroke, despite a focus on repetitive practice, and they demonstrated a limited range of movement options. Conversely, Nonlinear Pedagogy advocates for practice environments that offer scenarios requiring the learner to "replicate" movement skills in diverse and dynamic contexts, as these more authentic "practices" often do not challenge the learner in identical ways (i.e., the principle of repetition without repetition).

Task simplification requires practitioners to acknowledge the need of enhancing the execution of movement skills while preserving a robust perception-action link. This pertains to the simplification of movement behavior while preserving its spatial and temporal components. This contrasts with task decomposition, which involves breaking the movement into individual components before ultimately integrating them. Nonlinear Pedagogy advocates for task simplification, enabling practitioners to facilitate successful movement execution while ensuring that the practice remains representative of actual performance contexts (J. Y. Chow, Komar, & Seifert, 2021). In junior sports, there are typically fewer players in modified games, and the equipment, such as rackets and balls, is often scaled to the size of the players or modified to decrease task difficulty. This represents a common method of task simplification observed in various modified games designed for younger children.

Informational constraints represent a significant factor to consider in students. Practitioners often favor verbal instructions that highlight the movement's form For instance, flex your knees while positioning to shoot in basketball, and pivot your body when ready to strike the ball in tennis. This approach may lead to increased conscious control of the movement, a phenomenon commonly observed in Linear Pedagogy scenarios. Conversely, informational limitations that highlight the end or consequence of movement can be beneficial, exemplified by the trajectory of the shuttlecock in badminton and the analogy of crab-like movement for lateral motion in the development of core movement skills. Children tend to focus on playing the game and achieving specific outcomes, often prioritizing results over movement forms typically emphasized in disciplines such as dance or gymnastics. Utilizing analogy to characterize movement may diminish focus on the precise biomechanics of the action, thereby facilitating broader exploration and personalization of movement adaptation (Rudd et al., 2021). Lee et al. (2014) illustrated the efficacy of utilizing analogies in adapted tennis that emphasize movement results, such as likening ball trajectory to a rainbow and racket motion to climbing a mountain slope. This method yielded a range of movement solutions that were as successful as conventional prescriptive instructions for the movement itself.substantially concerning the techniques they may utilize to achieve it. Informational limitations may be beneficial even for activities regarded as such.

The significance of practice variations has been well examined, endorsing exploratory behaviors (Button et al., 2013). Variability in practice can be enhanced through various methods by strategically manipulating task constraints. The utilization of objects of varying sizes for sticking or throwing, the modification of rules, and the introduction of diverse obstacles for navigation are notable examples. The primary challenge lies in determining the degree of variability that can be integrated into practices to promote exploratory behaviors. The premise necessitates careful consideration of performer constraints and their potential interactions with the task and environment to facilitate the emergence of movement behavior. The design of variability in practice aims to promote diverse movement

behaviors that do not replicate the same movement form. Instead, it emphasizes engaging learners to achieve task goals through the demonstration of various movement forms (B. C. Chow et al., 2009). The aim should be to proficiently integrate and devise practice variations inside the sessions. Movement variety likely enhances learning results. This pertains to the significance of movement abilities in dynamic performance environments, such as gymnastics, where the execution of the vault cannot be perfectly duplicated. In Linear Pedagogy, the goal is for learners to reproduce the movement with little variability in accordance with a predetermined movement pattern. This differs from Nonlinear Pedagogy, which advocates for various routes to achievement, as elaborated upon before in this section.

The final design principle regarding constraints manipulation appears to be fundamental to all design principles, as it supports the implementation of the other principles. Through the manipulation of constraints, practitioners can establish more representative practices, streamline tasks, adjust informational constraints, and introduce varying levels of variability in practice. It is important to recognize that representativeness must align with the individual's needs and the intended learning outcome. The previously discussed study on representativeness and donor/multi-sports necessitates an examination of the transfer of learning. Consequently, the skill of manipulating limitations is essential for any practitioner aiming to implement effective instructional techniques within the context of Nonlinear Pedagogy. In Linear Pedagogy, restrictions, especially task limitations, are adjusted and employed to improve practices. The main difference resides in the suitable use or adjustment of these task restrictions to guide exploration, search, and exploitation of individualized movement solutions within a representative learning context. This process, fundamental to a Nonlinear Pedagogical approach, differentiates it from a traditional Linear Pedagogy method.

Nonlinear Pedagogy In Primary School Physical Education

Small-Sided and Conditioned Matches

In recent decades, personalized games have attained considerable appeal, especially within national sports initiatives. Modified sports programs are accessible to children of primary school age, often ranging from 4 to 12 years, worldwide; however, the upper age limit varies across programs. Modified sports include several activities from the Australian Football League (2014), Netball Australia (2014), Football Federation Australia (2015), Tennis Australia (2015), French Handball Federation (2019) (Handball), and French Rugby Federation (2021) (Rugby), among others. Modified sport programs are explicitly crafted to involve children in play activities that promote the development of essential motor skills and sport-specific competencies for future performance.(Côté et al., 2020). The sport is tailored to correspond with children's developmental abilities by adjusting games and activities through changes in rules, equipment, and/or physical space to foster inclusion and improve participation (i.e., essential manipulation of task constraints) (Astuti et al., 2023). The primary focus of modified sport programs is on learning and development, including age-appropriate competition, rather than on competition per se. Modifying the game might be viewed as a method to ensure the representativeness of the practice. The aim of training and learning adaptations in games can serve as an effective tool for implementing the core concepts of Nonlinear Pedagogy.

Beyond Small-Sided and Conditioned Games: Significance of Task Modification

Although SSCG is the most common, there are other ways to modify games to affect player behavior and learning. Oppici (2018) found that football players' perceptual abilities can be affected by changed balls. They found that training with a modified football ball increased passing performance and perceptual attunement. Previous research showed that early futsal practice improves football performance and skill mastery (Idarraga & Valencia-Sánchez, 2024). The authors suggested changing the ball or other task limitation to affect learning. Other game limitations like scoring rules, player count, and court size can be changed to improve player learning. Thus, SSCG is merely one constraint manipulation strategy in modified games, and other viewpoints have shown positive outcomes in football and other sports.
A modified ball improved field hockey skills in a recent study (Brocken et al., 2020). The researchers demonstrated that altered apparatus enhanced the diversity of learners' movements, which is believed to facilitate skill performance. Brocken et al. (2020) found that manipulating ball attributes increased player performance (since it's easier to use) and learning by boosting movement execution redundancy. As indicated earlier, Limpens et al. (2018) Demonstrated how alterations in net height instantaneously influenced player movement. Decreasing net height raised the winning percentage. Players took fewer

shots per rally as net height climbed. This study's premise was predicated on net height as a percentage of children's height at the age of practice (i.e., the average height of 10-year-olds), which signifies equipment modification adjusted to player limitations. Altering the game or equipment according to players' constraints is a pertinent method to influence task limitations irrespective of skill level. This innovative approach to modifying task restrictions streamlines the activity and enables junior athletes to achieve success irrespective of their skill levels (Limpens et al., 2018) while preserving a robust and pertinent connection between perception and action.

Use of Nonlinear Pedagogy Challenges

Nonetheless, although Nonlinear Pedagogy offers benefits, practitioners may still encounter problems. Chow (2013) identified problems related to the necessity of possessing comprehensive knowledge of the sport/game/activity to implement suitable constraint alterations that successfully guide learners' search behaviors. Moreover, preparing the pertinent activity location or equipment might be time-consuming, particularly in a school environment where the teacher must transition between classes for various student groups. Comprehensive and precise planning for instruction and learning is essential for the execution of lessons based on Nonlinear Pedagogy. Practitioners may first encounter difficulty when implementing Nonlinear Pedagogy due to a perceived relinquishment of control over session advancement, as fewer prescriptive instructions are given to students, notwithstanding the resultant autonomy in learning being conferred to the learners. Practitioners may feel uneasy in a scenario where they must appear to manage the learning environment (J. Y. Chow, 2013).

Results

Table 2. Research Findings

Research finding
The Relationship Between Ecological Dynamic dan Nonlinear Pedagogy
Overall, Ecological Dynamics offers a robust framework for understanding skill acquisition and performance in sports by emphasizing adaptability, exploration, and the dynamic interaction between individuals and their environments (Rudd et al., 2021).
Research finding
Significant Dimensions of Nonlinear Pedagogy
There are several key dimensions such as Representativeness, Task Simplification, Informational Constraints, Practice Variability, and Constraints Manipulation. These dimensions collectively aim to foster a learner-centered approach that prioritizes adaptability, exploration, and skill transfer across different contexts in sports and physical education (J. Y. Chow, Komar, & Seifert, 2021).
Research finding
Significant Dimensions of Ecological Dynamic
Combines principles from ecological psychology and dynamical systems theory, depiction of students as sports teams as complex adaptive systems, and also Emphasizes continuous interaction between learners and their environment (H. S. Lee & Lee, 2021; Rudd et al., 2020).
Research finding
Variability of Results Between Studies
Despite the majority of studies indicate a favorable correlation, there exists variability in outcomes among the investigations. Elements including study design, sample size, and measuring techniques may have influenced the variation in outcomes.
Research finding
Variability of Results Between Studies
Clear improvements in performance accuracy scores over time in nonlinear pedagogy (NP) groups, Significant enhancement in game skills development, particularly in territorial games like football. Greater number of movement clusters observed in NP groups, indicating successful development of multiple ways to achieve the same outcome (M. C. Y. Lee et al., 2014).
Research finding
The Importance of Context in Relationships
Learning occurs through ongoing problem-solving rather than mere repetition, with skills emerging through dynamic interactions (J. Y. Chow, Komar, Davids, et al., 2021).
Research finding
The Importance of Context in Relationships
External factors, the successful implementation of nonlinear pedagogy requires consideration and management of these external factors to create effective learning environments that support student development and achievement of physical education goals (Raposo et al., 2019).

Discussion

In discussing the implications of the findings, comprehensive analysis of the relationship between nonlinear teaching and ecological dynamics. It was discovered This paper offers a comprehensive analysis of the relationship between nonlinear teaching and ecological dynamics. It was found The integration of ecological dynamics and nonlinear pedagogy provides a robust framework for

understanding skill acquisition in physical education (Seifert & Davids, 2017), Movement patterns emerge through complex interactions between learners and their environment rather than prescribed forms, Learning occurs through ongoing problem-solving rather than mere repetition of movements. The teacher's role is important as a facilitator in physical education learning. The teacher can provide indirect instructions to obtain the desired movement skills or responses. A discovery underscores the significant significance of motivated feedback in motor learning (Chiviacowsky & Drews, 2016). Strong evidence also shows the effectiveness of feedback interventions on students' skill learning compared to those who did not receive feedback (Zhou et al., 2021).

This research substantially enhances our comprehension of nonlinear teaching and dynamic ecology. The findings complement the scientific literature Movement patterns emerge through complex interactions between learners and their environment, not through prescribed forms, Learning occurs through exploratory processes with self-generated feedback rather than explicit instruction, The individual-environment relationship is central to understanding learning processes (Moy et al., 2016; Rudd et al., 2021). These findings are relevant to support a learner-oriented learning approach. Non Linear Pedagogy emphasizes a learner-centered methodology that emphasizes the significant role of practitioners as facilitators in delivering meaningful practice, which fosters the transfer of effective gaming behaviors (Machado et al., 2019). Teachers need to move from a cyclical separation of learning and performance to a more integrative approach where the learning environment is designed in detail to contextualize learning (Renshaw et al., 2022). Article proposes that physical education teachers and coaches design learning environments with a nonlinear pedagogical approach, thereby better framing the microstructure of practice compared to the utilization of traditional pedagogical practices (Correia et al., 2019). The idea articulates that a representative learning environment can enhance learning and foster the growth of intelligent and creative individuals (Machado et al., 2019). Several research results support the success of non-linear and dynamic ecological learning. Research results show that a tactical game approach can improve metacognitive behavior in physical education classes in elementary schools (Chatzipanteli et al., 2016). The results show that the Non Linear Pedagogy intervention program is effective in improving both aspects of team game performance among youth footballers (Práxedes et al., 2019)

It is crucial to recognize the methodological constraints inherent in this investigation. These guidelines encompass particular systematic designs and restrictions governing the available data. It is important to acknowledge that specific inadequacies in data or methodology may restrict the generalizability of these findings to the broader community of nonlinear pedagogy and dynamic ecology students. These limitations necessitate further extensive follow-up research.

Future studies should further examine the correlation between nonlinear pedagogy and additional characteristics that may mitigate or mediate this association. A study may investigate role class size effects on nonlinear pedagogy implementation, available practice time influence on learning outcomes, equipment modifications' impact on skill development. By examining these elements, we can attain a more comprehensive grasp of the concept of ecological dynamics in nonlinear pedagogy.

Conclusions

Nonlinear pedagogy and ecological dynamics provide powerful frameworks for understanding skill acquisition and learning in physical education, particularly in primary school settings. The learning process involves the emergence of movement patterns through intricate interactions between learners and their environment, rather than through predetermined forms. Learning occurs through ongoing problem-solving and exploratory processes rather than mere repetition and also task simplification proves more effective than task decomposition for skill development. Evidence in several studies reviewed suggests that although nonlinear pedagogy offers promising results in skill acquisition and student motivation, its successful implementation requires careful consideration of contextual factors and appropriate support systems for teachers and students. However, in some studies it is important to acknowledge the heterogeneity of results between studies and the limitations of these studies, which suggests the need for additional investigations to improve our understanding of these relationships. This study in a review of articles related to nonlinear pedagogy sets the foundation for future research

that may influence future approaches to understanding the impact of nonlinear pedagogy on improving physical education learning efficacy.

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Conflict of interest

No potential conflict of interest was reported by the authors.

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